CLAIMS:

We Claims:

1. A vehicle, comprising

a ground speed sensor arranged to detect the speed of travel of the vehicle on the ground,

said ground speed sensor comprising

a wave transmitter arranged to transmit waves toward the ground,

a wave receiver arranged to received waves reflected from the ground after transmission by said wave transmitter, and

a processor coupled to said wave transmitter and said wave receiver and arranged to determine the speed of travel of the vehicle on the ground based on the waves transmitted by said wave transmitter and the waves received by said wave receiver,

the waves being transmitted by said wave transmitter in pulses or modulated such that said processor is able to determine the distance between a wave-transmission and reception point and the ground and the velocity of the vehicle based on analysis of the waves transmitted by said wave transmitter and the waves received by said wave receiver.

2. The vehicle of claim 1, further comprising a control unit for controlling said wave transmitter, said control unit being arranged to direct said wave transmitter to transmit waves in pulses.

3. The vehicle of claim 1, further comprising a control unit for controlling said wave transmitter, said wave transmitter including a modulator for enabling the transmission of modulated waves, said control unit being arranged to control said modulator such that said wave transmitter transmits modulated waves.

4. The vehicle of claim 1, further comprising a control unit for controlling said wave transmitter, said control unit being arranged to affect the transmission of waves by said wave transmitter to enable said processor to determine the distance between a wave-transmission and reception point and the ground based on an analysis of the waves transmitted by said wave transmitter and the waves received by said wave receiver.

5. The vehicle of claim 1, wherein said processor is arranged to determine the speed of travel of the vehicle on the ground based on the time difference between the transmitted waves and the received waves.

6. The vehicle of claim 1, further comprising:

storage means defining a compartment in which product to be distributed is stored;

a distribution mechanism for distributing the product;

a driving mechanism for conveying the product from said storage means to said distribution mechanism at a controlled rate; and

control means for controlling said driving mechanism,

said ground speed sensor being coupled to said control means to provide the detected speed of travel of the vehicle to said control means such that said control means controls said driving mechanism based on the detected speed of travel of the vehicle.

7. The vehicle of claim 6, further comprising a user interface coupled to said control means for enabling input of commands to said control means such that said control means controls said driving mechanism based in part on the commands input via said user interface.

8. The vehicle of claim 7, wherein said user interface comprises operator settings or input means.

9. The vehicle of claim 7, wherein said user interface comprises a display coupled to said control means for displaying information about the product.

10. The vehicle of claim 6, wherein said control means is arranged to calculate the rate at which said driving mechanism conveys product from said storage means to said distribution mechanism based on the detected speed of travel of the vehicle

11. The vehicle of claim 6, wherein said driving mechanism comprises a metering wheel rotatable at an adjustable rate and arranged in communication with said storage compartment to meter the product into said distribution mechanism, said control means being arranged to control the rotation rate of said metering wheel.

12. The vehicle of claim 6, further comprising a frame, said storage means, said distribution mechanism, said driving mechanism and said processor being arranged on said frame.

13. The vehicle of claim 6, wherein said distribution mechanism comprises at least one singulator disk arranged in communication with said storage compartment to meter the product into said

distribution mechanism, said control means being arranged to control the rotation rate of said at least one singulator disk.

14. The vehicle of claim 6, wherein said distribution mechanism comprises a pump having a variable output flow rate and arranged in communication with said storage compartment to vary the flow of the product into said distribution mechanism, said control means being arranged to control the output flow rate of said pump.

15. The vehicle of claim 6, further comprising a compass coupled to said control means to provide a directional heading of the vehicle to said control means such that said control means controls said driving mechanism based on the directional heading of the vehicle.

16. The vehicle of claim 1, wherein said ground speed sensor further comprises compensation means for eliminating the influence of a pitching angle of the vehicle on the detection of the speed of travel of the vehicle.

17. The vehicle of claim 1, wherein said wave transmitter is arranged to transmit waves which impact the ground at an angle θ and said processor is arranged to calculate the speed of the vehicle in the direction that the waves are transmitted ($V \cos \theta$) and then calculate the speed of travel of the vehicle in a horizontal plane (V) by dividing the speed of the vehicle in the direction that the waves are transmitted by $\cos \theta$.

18. The vehicle of claim 1, wherein said wave transmitter is arranged to transmit electromagnetic waves at a frequency f and which impact the ground at an angle θ and said processor is arranged to calculate the speed of the vehicle in the direction that the waves are transmitted ($V \cos \theta$) and then calculate the speed of travel of the vehicle in a horizontal plane (V) by dividing the speed of the vehicle in the direction that the waves are transmitted by $2f \cos \theta$ and multiplying by the electromagnetic wave propagation velocity.

19. The vehicle of claim 1, wherein said wave transmitter and said wave receiver are collocated in a common sensor.

20. The vehicle of claim 19, further comprising a frame and mounting means for movably mounting said sensor to said frame such that said sensor moves in a curve about a center of rotation of the

vehicle upon pitching of the vehicle whereby pitching of the vehicle changes rotates said sensor changing an effective transmission angle of said sensor relative to the ground.

21. The vehicle of claim 20, further comprising first measuring means for measuring the pitching angle of the vehicle and second measuring means for providing a reference angle for determining pitching of the vehicle, said first and second measuring means being coupled to said processor such that said processor determines the pitching of the vehicle relative to the ground based on the pitching angle measured by said first measuring means and the reference angle measured by said second measuring means.

22. The vehicle of claim 21, wherein said second measuring means comprise a gravity or tilt sensor.

23. The vehicle of claim 1, further comprising a two antenna GPS receiver for enabling measurement of the pitching angle of the vehicle relative to the ground.

24. The vehicle of claim 1, wherein said wave transmitter is arranged to transmit waves at an known angle to the ground, said processor being arranged to calculate the Doppler velocity and distance that the transmitted waves travel to the ground and return and calculate the pitching angle of the vehicle relative to the ground based on the known angle of transmission of the waves, the calculated Doppler velocity and the calculated distance of travel of the waves.

25. The vehicle of claim 1, further comprising a detection system for detecting contact between a rear portion of the vehicle and the ground, said processor being arranged to provide the speed of travel of the vehicle on the ground only when said detection system detects contact between the rear portion of the vehicle and the ground.

26. The vehicle of claim 1, further comprising a frame, said wave transmitter being mounted on said frame to transmit waves at an angle of about 35° to the ground when said frame is level.

27. The vehicle of claim 1, further comprising a frame, said wave transmitter and said receiver being mounted on said frame at a height of at least 1 meter from a bottom of the vehicle.

28. The vehicle of claim 1, wherein said processor comprises means for compensating for slipping of a wheel of the vehicle.

29. The vehicle of claim 1, further comprising a display coupled to said ground speed sensor for displaying the detected speed of travel of the vehicle.

30. The vehicle of claim 1, further comprising a temperature sensor coupled to said processor and arranged to measure ambient temperature, said processor being arranged factor in the ambient temperature as measured by said temperature sensor in the determination of the speed of travel of the vehicle.

31. The vehicle of claim 1, further comprising a barometric sensor coupled to said processor and arranged to measure atmospheric pressure, said processor being arranged factor in the atmospheric pressure as measured by said barometric sensor in the determination of the speed of travel of the vehicle.

32. The vehicle of claim 1, further comprising an anemometer coupled to said processor and arranged to measure wind speed, said processor being arranged factor in the wind speed as measured by said anemometer in the determination of the speed of travel of the vehicle.

33. The vehicle of claim 1, further comprising a bulldozer body, said wave transmitter and said wave receiver being arranged on said bulldozer body.

34. The vehicle of claim 1, wherein said wave transmitter comprises at least one laser.

35. The vehicle of claim 1, wherein said wave transmitter comprises a pulsed laser.

36. The vehicle of claim 1, wherein said wave transmitter comprises a continuous laser beam directing infrared light to scan in a line and transmitter control means for controlling said scanning laser beam of infrared light such that the infrared light traverses an area of the ground near the vehicle.

37. The vehicle of claim 36, wherein said wave receiver comprises a single pixel receptor.

38. The vehicle of claim 1, wherein said wave receiver comprises at least one of a CCD array, a CMOS array and an HDRC camera, a dynamic pixel camera and an active pixel camera.

39. The vehicle of claim 1, wherein said wave transmitter is arranged to transmit ultrasonic waves and said wave receiver is arranged to receive ultrasonic waves.

40. The vehicle of claim 1, wherein said wave transmitter is arranged to transmit radar waves and said wave receiver is arranged to receive radar waves.

41. The vehicle of claim 1, wherein said wave transmitter is arranged to transmit infrared waves and said wave receiver is arranged to receive infrared waves.

42. The vehicle of claim 1, wherein said wave transmitter is arranged to transmit electromagnetic waves and said wave receiver is arranged to receive electromagnetic waves, said processor being arranged to determine both the distance between a wave transmission and reception point and the ground based on a phase difference or time of flight between the transmitted and received waves and the speed of travel of the vehicle on the ground based on the Doppler velocity.

43. The vehicle of claim 42, wherein said wave receiver comprises a notch filter for filtering light other than infrared light emitted by said wave transmitter.

44. The vehicle of claim 42, wherein said wave receiver comprises a light valve.

45. The vehicle of claim 1, wherein said processor is arranged to determine the speed of travel of the vehicle on the ground based on a plurality of time intervals between transmission of waves by said wave transmitter and reception of waves by said wave receiver.

46. The vehicle of claim 1, wherein said processor is arranged to determine the speed of travel of the vehicle on the ground based on a measurement of the Doppler frequency.

47. The vehicle of claim 1, wherein said wave transmitter and said wave receiver are collocated in a common sensor, further comprising:

a frame, said sensor being movably mounting to said frame such that said sensor moves in a curve about a center of rotation of the vehicle upon pitching of the vehicle whereby pitching of the vehicle changes rotates said sensor changing an effective transmission angle of said sensor relative to the ground;

first measuring means for measuring the pitching angle of the vehicle;

second measuring means for providing a reference angle for determining pitching of the vehicle, said first and second measuring means being coupled to said processor such that said processor determines the pitching of the vehicle relative to the ground based on the pitching angle measured by said first measuring means and the reference angle measured by said second measuring means;

an additional wave transmitter and wave received collocated in an additional common sensor, said additional common sensor being movably mounting to a side of said frame such that said additional common sensor moves in a curve about a center of rotation of the vehicle upon roll of the vehicle whereby roll of the vehicle changes rotates said additional common sensor changing an effective transmission angle of said additional common sensor relative to the ground;

third measuring means for measuring the roll angle of the vehicle;

fourth measuring means for providing a reference angle for determining roll of the vehicle, said third and fourth measuring means being coupled to said processor such that said processor determines the roll of the vehicle relative to the ground based on the roll angle measured by said third measuring means and the reference angle measured by said fourth measuring means; and

whereby an inertial measurement unit is formed by said first, second, third and fourth measuring means, said compass, said wave transmitter, said wave receiver and said processor.

48. A vehicle, comprising

wave emitting means arranged on the vehicle for emitting waves at an angle toward the ground near the vehicle, and

receiver means arranged on the vehicle for receiving waves reflected from the ground near the vehicle;

a vehicular system adapted to be controlled or adjusted based on the velocity of the vehicle relative to the ground; and

a processor coupled to said wave emitting means, said receiver means and said vehicular system for determining the velocity of the vehicle relative to the ground and the distance to the ground based on the transmission of waves by said wave emitting means and reception of waves by said receiver means and using the determined distance to correct the determined velocity of the vehicle relative to the ground and controlling the vehicular system based on the corrected velocity,

the waves being transmitted by said wave emitting means in pulses or modulated such that said processor is able to determine the distance between a wave-transmission and reception point and the ground and the velocity of the vehicle based on analysis of the waves transmitted by said wave emitting means and the waves received by said wave receiver means.

49. The vehicle of claim 48, wherein said processor is arranged to measure time between transmission of the waves by said wave emitting means and reception of the waves by said receiver means.

50. The vehicle of claim 48, further comprising a control unit for controlling said wave emitting means, said control unit being arranged to direct said wave emitting means to emit waves in pulses.

51. The vehicle of claim 48, further comprising a control unit for controlling said wave emitting means, said wave emitting means including a modulator for enabling the transmission of modulated waves, said control unit being arranged to control said modulator such that said wave emitting means transmits modulated waves.

52. The vehicle of claim 48, further comprising a control unit for controlling said wave emitting means, said control unit being arranged to affect the transmission of waves by said wave emitting means to enable said processor to determine the distance between a wave-transmission and reception point and the ground based on an analysis of the waves transmitted by said wave emitting means and the waves received by said receiver means.

53. The vehicle of claim 48, wherein said wave emitting means is arranged to transmit ultrasonic waves and said receiver means is arranged to receive ultrasonic waves, said processor being arranged to determine both the distance between a wave transmission and reception point and the ground based on a time of flight between the transmitted and received waves and the speed of travel of the vehicle on the ground based on the Doppler velocity.

54. The vehicle of claim 48, wherein said wave emitting means is arranged to transmit electromagnetic waves and said receiver means is arranged to receive electromagnetic waves, said processor being arranged to determine both the distance between a wave transmission and reception point and the ground based on a phase difference or time of flight between the transmitted and received waves and the speed of travel of the vehicle on the ground based on the Doppler velocity.

55. An agricultural product distribution vehicle, comprising: storage means for storing agricultural product to be distributed;

conveying means for conveying agricultural product from said storage means to the ground; and

control means for controlling a rate of transfer of the agricultural product from said storage means through said conveying means for distribution to the ground, said control means including an operation system for automatically controlling the transfer of agricultural product at a rate dependent on the product to be distributed and the determined average needs of the field and the vehicle ground speed and a user interface for inputting operator settings related to the product and field properties; and

a ground speed sensor arranged to detect the speed of travel of the vehicle on the ground,

said ground speed sensor comprising

a wave transmitter arranged to transmit waves toward the ground,

a wave receiver arranged to received waves reflected from the ground after transmission by said wave transmitter, and

a processor coupled to said wave transmitter and said wave receiver and arranged to determine the speed of travel of the vehicle on the ground based on the waves transmitted by said wave transmitter and the waves received by said wave receiver,

the waves being transmitted by said wave transmitter in pulses or modulated such that said processor is able to determine the distance between a wave-transmission and reception point and the ground and the velocity of the vehicle based on analysis of the waves transmitted by said wave transmitter and the waves received by said wave receiver.

56. The vehicle of claim 55, further comprising a control unit for controlling said wave transmitter, said control unit being arranged to direct said wave transmitter to transmit waves in pulses.

57. The vehicle of claim 55, further comprising a control unit for controlling said wave transmitter, said wave transmitter including a modulator for enabling the transmission of modulated waves, said control unit being arranged to control said modulator such that said wave transmitter transmits modulated waves.

58. The vehicle of claim 55, further comprising a control unit for controlling said wave transmitter, said control unit being arranged to affect the transmission of waves by said wave transmitter to enable said processor to determine the distance between a wave-transmission and reception point and the ground based on an analysis of the waves transmitted by said wave transmitter and the waves received by said wave receiver.

59. The vehicle of claim 55, wherein said wave transmitter is arranged to transmit ultrasonic waves and said wave receiver is arranged to receive ultrasonic waves, said processor being arranged to

determine both the distance between a wave transmission and reception point and the ground based on a time of flight between the transmitted and received waves and the speed of travel of the vehicle on the ground based on the Doppler velocity.

60. The vehicle of claim 55, wherein said wave transmitter is arranged to transmit electromagnetic waves and said wave receiver is arranged to receive electromagnetic waves, said processor being arranged to determine both the distance between a wave transmission and reception point and the ground based on a phase difference or time of flight between the transmitted and received waves and the speed of travel of the vehicle on the ground based on the Doppler velocity.